

BIOGEOCHEMICAL MODELING AT MASS EXTINCTION BOUNDARIES

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The causes of major mass extinctions is a subject of considerable interest to those concerned with the history and evolution of life on earth. The primary objectives of the proposed plan of research are: 1) to develop quantitative time-dependent biogeochemical cycle models, coupled with an ocean atmosphere in order to improve our understanding of global scale physical, chemical, and biological processes that control the distribution of elements important for life at times of mass extinctions, and 2) to develop a comprehensive data base of the best available geochemical, isotopic and other relevant geologic data from sections across mass extinction boundaries. These data will be used to constrain and test the biogeochemical model. These modeling experiments should prove useful: 1) in determining the possible cause(s) of the environmental changes seen at bio-event boundaries, 2) in identifying and quantifying little-known feedbacks among the oceans, atmosphere and biosphere, and 3) in providing additional insights into the possible responses of the earth system to perturbations of various timescales.

One of the best known mass extinction events marks the Cretaceous/Tertiary (K/T) boundary (66 Myr ago). Data from the K/T boundary are used here to constrain a newly developed time-dependent biogeochemical cycle model that is designed to study transient behavior of the earth system. Model results predict significant fluctuations in ocean alkalinity, atmospheric CO₂, and global temperatures caused by extinction of calcareous plankton and reduction in the sedimentation rates of pelagic carbonates and organic carbon. Oxygen-isotope and other paleoclimatic data from K/T time provide some evidence that such climatic fluctuations may have occurred, but stabilizing feedbacks may have acted to reduce the ocean alkalinity and carbon dioxide fluctuations.